GOVERNOR'S OFFICE OF
ENERGY DEVELOPMENT
Advancing Utah's Energy Future

Building Batteries - Middle School

Grade 8th Integrated Science

Strand/Standard 8.1.2 Obtain information about various properties of matter, **evaluate** how different materials' properties allow them to be used for particular functions in society, and **communicate** your findings.

Lesson Performance Expectations (description): Students will investigate the construction of batteries based on how different materials react with one another to produce electricity.

Materials: Per group:

- 200 ml beaker
- solutions of salt water
- strips of metals (https://www.carolina.com/electrochemistry/metal-strips-set-laboratory-grade/874850.pr)
- wires with alligator clips
- Voltmeter
- 1.5 volt motor-attach a paper propeller to show motion

Time: 120 minutes

Teacher Background Information:

- "You cannot catch and store electricity, but you can store electrical energy in the chemicals inside a battery." -Antoine Allanore, MIT, Department of Materials Science and Engineering
- The development of improved batteries is essential for the increasing electronic age we live in. Students need a well-developed understanding of batteries, how they work, what the limitations are and what their uses are. This lesson will focus on how batteries work and what kinds work for what uses. Background knowledge of the chemical nature of batteries can be found at: https://engineering.mit.edu/engage/ask-an-engineer/how-does-a-battery-work/

Student Background Knowledge:

- Students need a baseline understanding that substances are made of atoms and molecules and that they interact with one another.
- Substances are different because of differences in their atoms or molecules.
- Students need to understand the basic nature of electricity (moving electrons). They should understand that a circuit carries electricity from one place to another in a connected circle.

Teacher Step by Step:

The following steps are used in the design of the lesson :

1. **Engage: Introduce *Phenomenon:*** *Demonstrate building a battery using the materials listed. Students may perform this in groups if you have enough equipment. A battery can work in a single beaker with copper and zinc and salt water typically producing the greatest voltage.*
2. **Explore:** Ask students to write questions that they have about the phenomenon.
3. **Explain**: Tell students that they will research battery types, evaluate them and communicate their findings.

4. **Elaborate**: To help them summarize what they have learned in the, they could access these websites or you could share the sites as a class: https://www.explainthatstuff.com/batteries.html or https://engineering.mit.edu/engage/ask-an-engineer/how-does-a-battery-work/
5. **Evaluate:** The students could communicate their learning in a variety of ways. A poster, slide for a class powerpoint, or short written report are suggestions. Students may answer the multiple choice questions provided below. A list of battery types is listed after the student sheet.

Assessment of Student Learning.

Diagram of a Battery

1. What does the movement of electrons from electrode to electrode produce?
    a. Electricity*
    b. Waves
    c. New elements
    d. Light

Use the data to answer the next two questions:

Characteristics of Battery Types

Battery	Cycle Life (80% discharge)	Cell Voltage	Self-discharge/mo.
Lead-acid	200-300	2V	5%
NiCd	1000	1.2V	20%
NiMH	300-500	1.2V	30%
Lithium ion (cobalt)	500-1000	3.6V	<10%

https://www.pveducation.org/pvcdrom/battery-characteristics/summary-and-comparison-of-battery-characteristics

2. Which factor makes Lithium ion batteries attractive?
    a. Longer cycle life.
    b. Less expensive.
    c. Lowest self discharge rate.
    d. Higher voltages are possible.*

3. Which characteristic makes the NiMH battery more attractive than the NiCd?
    a. NiMH has a longer cycle life. *
    b. NiMH has a greater cell voltage.
    c. NiMH has a shorter self-discharge rate.
    d. NiMH is less expensive.

4. Which factors influence the battery type people choose for a task? Choose all that apply.
    a. cost*
    b. appearance
    c. lifespan*
    d. size*

5. Why are scientists searching for new ways to store energy in batteries? Choose all that apply.
    a. Batteries are portable.*
    b. Batteries can store energy from alternative sources.*
    c. Batteries can create new sources of clean energy.
    d. Batteries are inexpensive to produce and recycle.

Extension of lesson and Career Connections:
Use the voltmeter to determine which light bulbs can be lit and light the bulb.
https://www6.slac.stanford.edu/news/2019-02-05-untangling-strange-phenomenon-both-helps-and-hurts-lithium-ion-battery-performance

Student Page **Name_____**

Title: Batteries

Phenomenon: Watch as your teacher makes a battery:

What do you notice?

What questions do you have?

Guiding question: Which substances produce the best batteries?

Obtain information on which battery? _____ (Choose a battery type to research from the list below.)

Which internet resources did you look up? (use the names of the pages)

What information did you find? Be ready to communicate with your class as directed by your teacher.

Battery Types:

Primary Cells or Non-Rechargeable	Secondary Cells or Rechargeable

• Alkaline battery (zinc manganese oxide, carbon)
• Aluminium–air battery
• Atomic battery
• Bunsen cell
• Chromic acid cell (Poggendorff cell)
• Clark cell
• Daniell cell
• Dry cell
• Earth battery
• Frog battery
• Galvanic cell
• Grove cell
• Leclanché cell
• Lemon/potato battery
• Lithium battery
• Lithium air battery
• Magnesium battery
• Mercury battery
• Molten salt battery
• Nickel oxyhydroxide battery
  ○ Oxyride battery
• Organic radical battery
• Paper battery
• Pulvermacher's chain
• Silver-oxide battery
• Solid-state battery
• Sugar battery
• Voltaic pile
  ○ Penny battery
  ○ Trough battery
• Water-activated battery
• Weston cell
• Zinc–air battery
• Zinc–carbon battery
• Zinc chloride battery
	• Aluminium-ion battery
	• Carbon Battery
	• Flow battery
	  ○ Vanadium redox battery
	  ○ Zinc–bromine battery
	  ○ Zinc–cerium battery
	• Lead–acid battery
	  ○ Deep cycle battery
	  ○ VRLA battery
	  ○ AGM battery
	  ○ Gel battery
	• Glass battery
	• Lithium-ion battery
	  ○ Lithium ion lithium cobalt oxide battery (ICR)
	  ○ Lithium ion manganese oxide battery (IMR)
	  ○ Lithium ion polymer battery
	  ○ Lithium iron phosphate battery
	  ○ Lithium–sulfur battery
	  ○ Lithium–titanate battery
	  ○ Thin film lithium-ion battery
	  ○ Lithium ceramic battery [5] [6]
	• Magnesium-ion battery
	• Metal–air electrochemical cells
	  ○ Lithium air battery
	  ○ Aluminium–air battery
	  ○ Germanium air battery
	  ○ Calcium air battery
	  ○ Iron air battery
	  ○ Potassium-ion battery
	  ○ Silicon–air battery
	  ○ Zinc–air battery
	  ○ Tin air battery
	  ○ Sodium-air battery
	  ○ Beryllium air battery
	• Molten salt battery
	• Nickel–cadmium battery
	• Nickel hydrogen battery
	• Nickel–iron battery
	• Nickel metal hydride battery

	○ Low self-discharge NiMH battery ● Nickel–zinc battery ● Organic radical battery ● Polymer-based battery ● Polysulfide bromide battery ● Potassium-ion battery ● Rechargeable alkaline battery ● Rechargeable fuel battery ● Sand battery ● Silicon air battery ● Silver-zinc battery ● Silver calcium battery ● Silver-cadmium battery ● Sodium-ion battery ● Sodium–sulfur battery ● Solid-state battery [7] ● Super iron battery ● UltraBattery ● Zinc ion battery